California Regional PM_{10} and $PM_{2.5}$ Air Quality Study (CRPAQS)

Statement of Work – CRPAQS Data Analysis Task 7A
Visibility Characteristics in the San Joaquin Valley and Mojave Desert

STI-902333-2301-WP
Sonoma Technology, Inc.

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Introduction

Task 7A includes three visibility-related analyses: (1) animation of the light scattering by particles (b_{sp}) data throughout the study domain, (2) review of the presence of fog at monitoring sites, and (3) analysis of b_{sp} and meteorological data to determine the source areas that contribute to summertime light extinction in the Mojave Desert. Below is a statement of work, staffing plan, and schedule of deliverables for these task elements.

Scope of Work

Task Element 1: Animation of b_{sp} Data

STI will use in-house tools to animate the CRPAQS b_{sp} data for the entire study period. The new computer programs required for this effort include a batch processor to automate the process and a FORTRAN program to read CRPAQS format data and write data in the format required by the animation program. Revision of the San Joaquin Valley (SJV) base map to be consistent with other tasks is also planned.

The purpose of these animations is to improve CRPAQS analysts' access to the b_{sp} data, which are closely linked to $PM_{2.5}$ concentrations. Initially, the data will be helpful for Level 2 data validation by focusing attention on unusual events that deserve further analysis. They will also help analysts performing other tasks identify time periods and events that most deserve their attention. The animations will also help analysts select time periods for intensive analysis.

The FORTRAN program that converts data formats will calculate 20-minute average b_{sp} readings from the 5-minute average CRPAQS data. This averaging will smooth the spikes in the b_{sp} data caused by local emissions. Animations with 20-minute resolution for the entire CRPAQS study period will fit on one CD and can be made available on the Internet.

The animation computer program uses a smoothing algorithm to calculate a grid of b_{sp} readings from the measured data and a contouring program to calculate the display. The animation program can output the grid of smoothed data, which enables the calculation of differences between the smoothed and measured data. These differences provide an opportunity

to identify sites where the b_{sp} readings are typically higher or lower than at surrounding sites. The grids of smoothed data for the entire CRPAQS study period will fit on one CD.

Sample animations of unvalidated CRPAQS b_{sp} data from two days can be viewed at http://www.sonomatech.com/CRPAQS/BspAnimations. These animations were produced in February 2001. The colors shown for areas outside the CRPAQS study area have little significance in these preliminary versions of the animations.

Task Element 2: Determination of the Presence of Fog from Visibility and Related Measurements

Any instrument that responds to b_{sp} in the open air or a human observation of visibility can be used to record the presence and density of fogs. Until recent years, human observations of fog were made at airports and recorded in the National Weather Service Surface Airways database. Human observance is being replaced by Automated Surface Observing Systems (ASOS) at airports, and data from the ASOS visibility sensors also document the presence of fog. The ASOS precipitation sensors make it possible to distinguish when visibility is limited by heavy precipitation instead of fog. Two instruments developed for IMPROVE, the Optec Transmissometer and the NGN-2 open-air nephelometer, respond to fog. The transmissometer measures total light extinction, and the nephelometer measures b_{sp}. Open-air nephelometers were operated at Fresno, China Lake, and possibly other sites in the CRPAQS study area.

A related task (Task 3.3, Meteorological Monitoring Representativeness, to be performed by T&B Systems) will address the question, "How well do existing meteorological measurements represent the frequency, spatial extent, and intensity of fog?" It is likely that the findings of Task 3.3 will reveal that each of the instrumental measurement methods listed above provide a satisfactory record of the frequency and intensity of fog at the measurement location, but that fog is non-uniform on a spatial scale smaller than that of the sites with instruments that respond to fog (Main et al., 1998). It is possible that satellite photographs could be used to help compare the spatial scale of fog with the spatial scale of existing instrumental measurements. It is also possible that portions of some highways have a dense enough network of instruments to address the question of the spatial scale of fog events.

The California Department of Transportation (Caltrans) maintains a network of visibility sensors along major highways, such as Interstate 5, in the SJV. These sensors were installed to provide a warning of fog or severe dust events. Legal concerns may prevent accessing these data. If the data can be obtained, STI will use these data in the analyses in this task element of Task 7A.

The results of Task 3.3 will be reviewed in this task element. If warranted, STI will include in this task element a discussion of options for additional instrumentation to document the spatial patterns in the presence and severity of fog in the SJV.

Task Element 3: Visibility and Meteorological Analysis

Transport of pollutants from the South Coast Air Basin (SoCAB) into the southwestern portion of the Mojave Desert has been demonstrated by a variety of studies. Transport from the SJV has not received as much attention and its importance and frequency are not clear. Visibility degradation in the Mojave Desert, particularly at the China Lake and Edwards ranges, has become a major concern prompting a need to improve our understanding of the role of transport from the SJV.

Visibility impacts in the desert are primarily observable through measurements of b_{sp}. A network of nephelometers located along potential and known transport corridors from both the SJV and SoCAB were designed into the CRPAQS network specifically for this purpose. Sites at Tehachapi, Tejon, Barstow, China Lake, and Edwards were operated continuously for the entire 14-month study. Several additional sites were operated during the summer months, historically the worst observed instances of visibility degradation in the Mojave Desert. This latter set of sites consisted of Walker Pass, Cantil, near Bouquet Canyon, Soledad Canyon, and Cajon Pass. Nephelometer measurements at Edison and Oildale provide SJV boundary conditions.

For this task element, STI and T&B Systems will analyze the visibility and meteorological data to determine when and how often light extinction in the Mojave Desert is dominated by emissions from local sources, air pollutants transported from the SJV, and air pollutants transported from the SoCAB. In particular, we will

- statistically describe b_{sp} data collected at the Mojave Desert and transport corridor sites for diurnal behavior, day-to-day peak levels, and associated local surface meteorology;
- investigate the relationship between b_{sp} peaks at the sites upwind, along the transport corridors, and at the Mojave Desert;
- use back-trajectories prepared by the ARB or create back-trajectories from the Mojave Desert for episode days during the study using EDAS data and the National Oceanic and Atmospheric Administration's (NOAA) Air Resource Laboratory's trajectory model. We will review back-trajectories at various altitudes within the planetary boundary layer (PBL) and starting at various times of day to determine probable source areas and flow paths and compare these results to results from the b_{sp} analysis and analysis of local surface meteorological data;
- compare the back-trajectories to large-scale weather patterns to determine the meteorological conditions associated with various transport paths and poor visibility in the Mojave Desert; and
- compare results from this analysis to ENSR's chemical assessment of source types and areas (Task 7B).

Task Staffing and Management

Mr. Lyle Chinkin is STI's overall project manager. Clinton MacDonald is the task manager assigned to Task 7A. Willard Richards is the principal investigator for the animation of the b_{sp} data and review of the presence of fog. Siana Alcorn and Craig Anderson will assist

Dr. Richards with these task elements. Clinton MacDonald is the principal investigator for the visibility/meteorological task element and Don Lehrman will provide technical guidance and perform a portion of the work.

Schedule of Deliverables

Table 1 lists the deliverables to be prepared for Task 7A and their estimated delivery dates. The schedule for this task is somewhat dependent on the availability of results from other tasks. Additional time (and, potentially, resources) may be required if the products of other tasks are not received as planned.

Table 1. Estimated schedule of deliverables.

Deliverable	Deliverable Due Date
Submit final work plan	January 2003
Animations of b_{sp} data	February 2003
Perform review of presence of fog	May 2003
Perform analyses of b_{sp} and meteorological data to determine the source areas that contribute to summertime light extinction in the Mojave Desert	July 2003
Prepare draft technical memorandum	August 2003
Submit final technical memorandum	September 2003
Submit peer-reviewed paper and conference presentation	October 2003

ARB Staff Assigned to this Task

The ARB Project Manager assigned to this Task is:

Richard Hackney
Planning and Technical Support Division

Mailing Address:

California Air Resources Board
PO Box 2815
Sacramento, CA 95812
Ph.: (916) 322-6161
e-mail: rhackney@arb.ca.gov

Data Products to Be Performed/Delivered by ARB

ARB will supply STI with back-trajectories of specified episodes. STI will work with ARB to determine how the data will be transferred to STI and in what format(s) the data will be provided.

Software and Models to be used by STI

STI will use the following software to complete work under this task:

- Microsoft Word
- Microsoft Excel
- Microsoft Access
- ArcGIS 8.2
- HYSPLIT

References

Main H.H., Richards L.W., Hurwitt S.B., and Chinkin L.R. (1998) Characterization of the spatial and temporal patterns of visibility in the San Joaquin Valley during IMS-95. Final report prepared for the San Joaquin Valleywide Air Pollution Study Agency, c/o the California Air Resources Board, Sacramento, CA by Sonoma Technology, Inc., Petaluma, CA, STI-997217-1778-FR, July.